



GENERATOR INTERCONNECTION REQUEST

CLPT-G7 INTERCONNECTION FACILITIES STUDY

March 21, 2017

**PREPARED ON BEHALF OF
CHEYENNE LIGHT FUEL AND POWER
BY
BLACK HILLS CORPORATION
TRANSMISSION PLANNING**

EXECUTIVE SUMMARY

The Interconnection Facilities Study Report specifies and estimates the cost of the equipment, engineering, procurement and construction work needed to implement the conclusions of the Interconnection System Impact Study to physically and electrically connect a 102 MW wind generation facility to a new Cheyenne Light Fuel and Power (CLFP) 115 kV substation in Laramie County, Wyoming. The study was performed under the guidance of the CLFP OATT Large Generator Interconnection Procedures (LGIP). The project's transformer back-feed date is July 1, 2020 and has requested in-service date of December 31, 2020. The work, noted above, to accommodate the interconnection would be complete prior to the expected in-service date.

The total estimated cost of interconnecting the proposed facility is approximately \$5,940,000. The portion of the total costs that are direct-assigned to the Customer is \$480,000.

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1 DEFINITIONS

- 1.1 Balancing Authority (BA).** The responsible entity that integrates resource plans ahead of time, maintains load-interchange-generation balance within a Balancing Authority Area, and supports Interconnection frequency in real time.
- 1.2 Bulk Electric System (BES).** As Defined in NERC's BES Definition Guidance Document. The core BES Definition identifies the Real Power and Reactive Power resources connected at 100 kV or higher, as included in the BES.
- 1.3 Customer's Site.** Shall mean the fenced physical footprint necessary to accommodate the Generating Facility and other Interconnection Customer's Interconnection Facilities.
- 1.4 Distribution Upgrades.** Shall mean the additions, modifications, and upgrades to the Transmission Provider's Distribution System at or beyond the Point of Interconnection to facilitate interconnection of the Generating Facility and render the transmission service necessary to effect Interconnection Customer's wholesale sale of electricity in interstate commerce. Distribution Upgrades do not include Interconnection Facilities.
- 1.5 Generating Facility.** Shall mean Interconnection Customer's device for the production of electricity identified in the Interconnection Request, but shall not include the Interconnection Customer's Interconnection Facilities.
- 1.6 Independent Power Producer (IPP).** Any entity that owns or operates an electricity generating facility that is not included in an electric utility's rate base. This term includes, but is not limited to, cogenerators and small power producers and all other nonutility electricity producers, such as exempt wholesale generators, who sell electricity.
- 1.7 Interconnection Customer's Interconnection Facilities (ICIF).** Shall mean all facilities and equipment, as identified in Appendix A of the Standard Large Generator Interconnection Agreement, that are located between the Generating Facility and the Point of Change of Ownership, including any modification, addition, or upgrades to such facilities and equipment necessary to physically and electrically interconnect the Generating Facility to the Transmission Provider's Transmission System. Interconnection Customer's Interconnection Facilities are sole use facilities.
- 1.8 Joint Operating Committee.** Shall be a group made up of representatives from Interconnection Customers and the Transmission Provider to coordinate operating and technical considerations of Interconnection Service.
- 1.9 Local Provider.** Shall mean the utility providing "House Power" to the Generating Facility.
- 1.10 Network Upgrades.** Shall mean the additions, modifications, and upgrades to the Transmission Provider's Transmission System required at or beyond the point at which the Interconnection Facilities connect to the Transmission Provider's Transmission System to

accommodate the interconnection of the Large Generating Facility to the Transmission Provider's Transmission System.

- 1.11 **Other Network Upgrades.** Shall mean Network Upgrades that an Interconnection Customer may construct which would require interruption or modification of day-to-day operations of the Transmission Provider's Transmission or Sub-Transmission System during their construction. Both the Transmission Provider and the Interconnection Customer must agree as to what constitutes Stand Alone Network Upgrades and identify them in Appendix A to the Small Generator Interconnection Agreement.
- 1.12 **Point of Change of Ownership.** Shall mean the point, as set forth in Appendix A to the Standard Large Generator Interconnection Agreement, where the Interconnection Customer's Interconnection Facilities connect to the Transmission Provider's Interconnection Facilities.
- 1.13 **Point of Interconnection (POI).** Shall mean the point, as set forth in Appendix A to the Standard Large Generator Interconnection Agreement, where the Interconnection Facilities connect to the Transmission Provider's Transmission System.
- 1.14 **Stand Alone Network Upgrades.** Shall mean Network Upgrades that an Interconnection Customer may construct without affecting day-to-day operations of the Transmission System during their construction. Both the Transmission Provider and the Interconnection Customer must agree as to what constitutes Stand Alone Network Upgrades and identify them in Appendix A to the Standard Large Generator Interconnection Agreement.
- 1.15 **Sub-Transmission System.** A set of transmission lines of voltages between transmission voltages and distribution voltages. Generally defined as lines in the voltage range of 34.5 kV to 69 kV.
- 1.16 **Transmission Customer.** Any of the following responsible entities: Generator Owner, Load-Serving Entity, or Purchasing-Selling Entity.
- 1.17 **Transmission Owner (TO).** The entity that owns and maintains transmission facilities.
- 1.18 **Transmission Provider (TP).** The entity that administers the transmission tariff and provides Transmission Service to Transmission Customers under applicable Transmission Service agreements.
- 1.19 **Transmission Provider's Interconnection Facilities (TPIF).** Shall mean all facilities and equipment owned, controlled or operated by the Transmission Provider from the Point of Change of Ownership to the Point of Interconnection as identified in Appendix A to the Standard Large Generator Interconnection Agreement, including any modifications, additions or upgrades to such facilities and equipment. Transmission Provider's Interconnection Facilities are sole use facilities and shall not include Distribution Upgrades, Stand Alone Network Upgrades or Network Upgrades.

1.20 Transmission System. Shall mean the facilities owned, controlled or operated by the Transmission Provider or Transmission Owner that are used to provide transmission service under the Tariff.

2 INTRODUCTION

2.1 Scope & Objective

The objective of the facilities study is to:

- Complete a facilities analysis, which shall specify and estimate the cost of equipment (+/- 20%), engineering, procurement, and construction required to address issues as outlined in the system impact study, and
- Provide a scope of work and an estimated cost and schedule for completing the work.

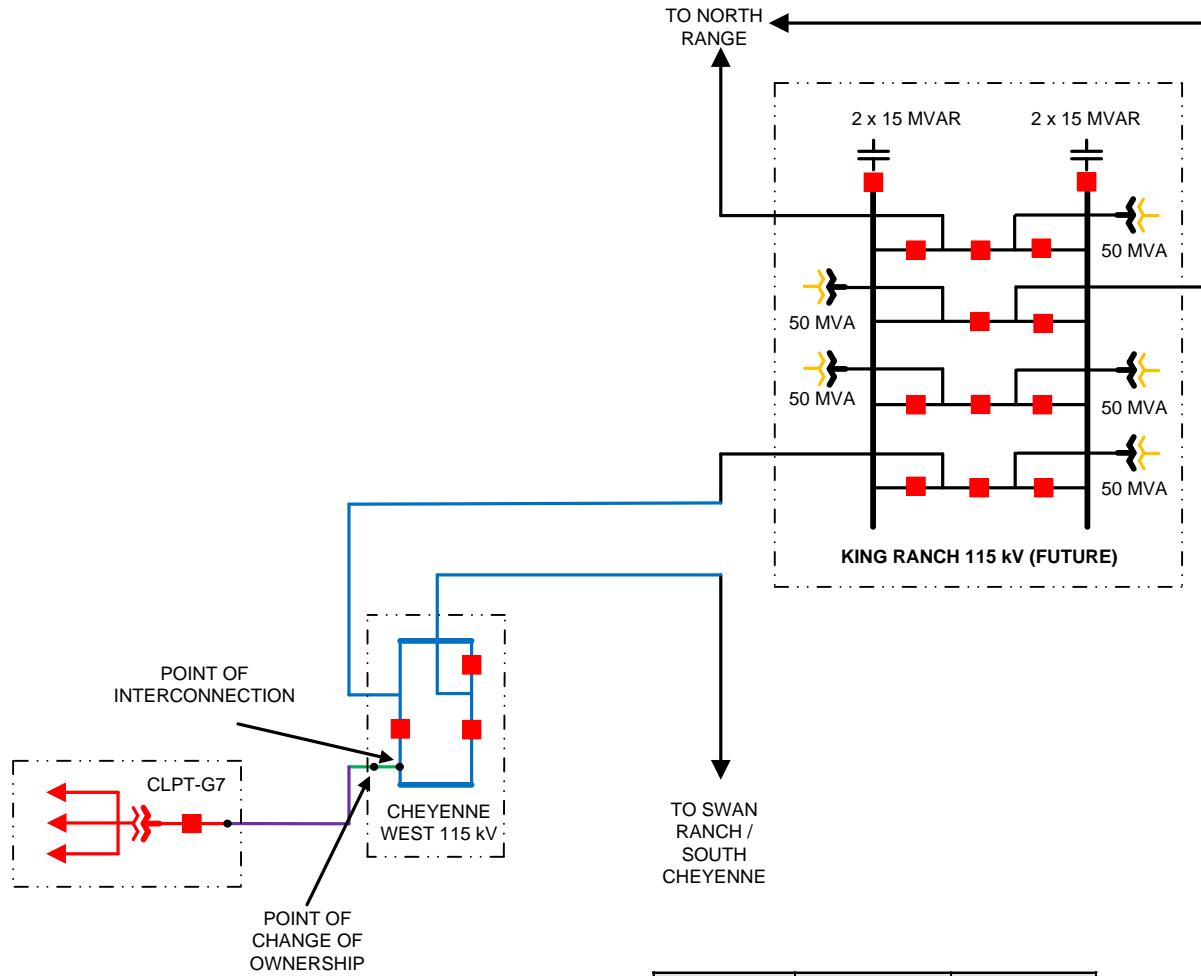
2.2 Background

The point of interconnection for the proposed CLPT-G7 project will be on the main bus of a new 115 kV West Cheyenne substation located west of Cheyenne, WY. The Customer has requested the TP evaluate the CLPT-G7 generation project utilizing Network Resource Interconnection Service (NRIS) and Energy Resource Interconnection Service (ERIS). A final designation of the type of service will be required prior to executing an interconnection agreement.

A System Impact Study (SIS) report for this project has been issued. The study was conducted in accordance with the Transmission Provider's (TP) Large Generator Interconnection Procedures (LGIP) and included power flow, transient stability, and short circuit analyses as well as preliminary cost and schedule estimates for interconnection of the Project. The SIS report concluded that the Project may be added with the following system upgrades, irrespective of the type of interconnection service selected (NRIS or ERIS):

- Construct a new 115 kV, 2000 Amp, 3-position ring bus 'West Cheyenne' substation.
- Construct 2.2 miles of double circuit 115 kV transmission line connecting West Cheyenne to a point bisecting the King Ranch-South Cheyenne 115 kV line.
- Install a PMU and Phasor Data Concentrator at the high side of the generator step-up (GSU) transformer terminals.

The anticipated date for back feed energy for CLPT-G7 is July 1, 2020 and the start of commercial operation is planned for December 31, 2020. See **Figure 1** for the Project layout.



		Financed By	Specified By	Operated By
—	Transmission Provider's Existing Facilities	TP	TP	TP
—	Transmission Provider's Interconnection Facilities	IC	TP	TP
—	Interconnection Customer's Interconnection Facilities	IC	IC/TP	IC
—	Network Upgrades	IC/TP	TP	TP
—	Generation Project	IC	IC	IC

Figure 1: CLPT-G7 Project Layout

3 INTERCONNECTION CUSTOMER'S INTERCONNECTION FACILITIES

3.1 General Discussion

The proposed project's Generating Facility is designed to output 102 MW. The Generating Facility would consist of fifty-one (51) GE 2.0 MW wind turbine generators including WindFREE Reactive Power technology.

The proposed project's ICIF would consist of all equipment between the Generating Facility and the Point of Change of Ownership. The Customer would construct the 115 kV generator tie line from Customer's Site to the Point of Change of Ownership within the West Cheyenne substation. Also required is a Phasor Measurement Unit (PMU) for the purposes of event recording and model validation per NERC Reliability Standard MOD-033. The generator tie line would approach the Point of Change of Ownership from the north of the West Cheyenne substation.

4 TRANSMISSION PROVIDER'S INTERCONNECTION FACILITIES

4.1 General Discussion

The proposed project's Transmission Provider Interconnection Facilities (TPIF) would consist of all equipment between the Point of Change of Ownership and the POI. The proposed project's Point of Change of Ownership is at the line jumpers at the top of the proposed project's generator tie line terminal A-frame structure in the West Cheyenne substation. The TPIF would include the jumpers from the A-frame structure to the revenue metering equipment as well as the metering equipment itself. A 115 kV disconnect switch is also included.

5 NETWORK UPGRADES

5.1 General Discussion

This project's Point of Interconnection would be defined as a new 115 kV substation, referred to in this report as West Cheyenne, which would bisect the King Ranch-South Cheyenne 115 kV line. The TP would design and construct three (3) 115 kV, 2000 amp transmission line terminals as part of the new ring bus. The 115 kV substation would include **3** substation breakers and **12** group operated disconnect switches.

The TP would also design and construct an 2.2-mile, double circuit 115 kV transmission line that would bisect the existing King Ranch-South Cheyenne 115 kV line and connect into the West Cheyenne substation. The line would be constructed using 795 ACSR Tern conductor and would be rated for 213 MVA continuous per circuit.

Also included in the network upgrades for the West Cheyenne substation are the required equipment support structures, terminal lightning arresters, overhead shielding, bus work, and terminal control & protection systems. Necessary modifications to the substation common equipment, cable trench, grounding system, and yard finish to accommodate the proposed generation facility are included. The electrical equipment enclosure and AC system for the future substation would provide adequate space and capacity for the additional equipment.

5.2 Civil Features

Necessary modifications to the new West Cheyenne substation yard finishes are included in the estimate.

5.3 Grounding

Necessary modifications to the substation grounding system are included in the cost estimate. The new terminal equipment would be grounded per TP standards. Customer would coordinate with the TP for grounding of the generator tie line at the Point of Change of Ownership.

6 FERC AND NERC COMPLIANCE REQUIREMENTS

6.1 Facility Ratings

Customer shall provide the TP with facility ratings of both the ICIF and the Generating Facility based upon industry standards and TP's transmission facility rating assumptions. The TP would rate its Interconnecting Facilities according to its methodology.

6.2 Facility BES Designation

This project's Interconnection Facilities and the Generating Facility would all be defined as part of the BES.

7 RIGHT OF WAY / PERMITTING

Customer would be responsible for any necessary land purchase, 115 kV right-of-way easements, storm water management plans, grading/erosion/sediment control and any necessary permits for the Customer's Site to extend to the Point of Change of Ownership. Costs associated with this requirement are not included in this cost estimate. The terms and cost of any transfer of property from the Customer to the TP for the expansion of the TP's substation are not included in this report.

8 ELECTRICAL FEATURES

8.1 Reactive Power Requirements

Customer's Generating Facility should maintain a composite power delivery at continuous rated power output at the high-side of the generator substation at a power factor within the range of 0.95 leading to 0.95 lagging at all levels of real power output, with the magnitude of reactive power calculated on the basis of nominal POI voltage (1.0 p.u.). According to the plant information provided by the Customer, no additional equipment is needed to meet the stated requirements.

8.2 Power Quality Impacts

Voltage unbalance limited to 1 percent or less, current unbalance limited to 5 percent or less. Voltage and current harmonics resulting from interconnected generator/load managed in accordance with IEEE Standard 519.

9 PROTECTION FEATURES

9.1 System Protection and Coordination

Primary and secondary protection will be provided by the TP on all terminals.

9.2 Isolating devices

Isolating devices in the Customer's Generation Facility must be accessible by the TP, lockable in the open position, suitable for operation under all foreseeable operating conditions, have visible status indication, and may be gang or independent-pole operated. Isolating devices would not be operated without advance notice to affected parties, unless under emergency conditions.

9.3 Breaker Duty and Surge Protection

The short circuit analysis found that the proposed interconnection would not cause any negative system impacts. The new West Cheyenne substation 115 kV breakers would be rated to interrupt 40 kA.

10 CONTROLS

The TP would require control of the AGC set-point, as applicable, as well as any other control capability specified by the Joint Operating Committee.

11 METERING

At Customer's cost, Customer would purchase a revenue-grade metering package to be installed on the 115 kV terminal within the TP's substation. The TP would install, maintain, and operate the metering equipment. The meter would be capable of load and no-load loss compensation. The TP would require final approval of the metering package's specifications and would coordinate with Customer for final commissioning of the metering package.

Customer would be responsible for the cost to identify and implement all metering requirements of the Balancing Authority as detailed in the Western Area Power Administration Meter Policy. Costs associated with identifying and implementing metering requirements of the Balancing Authority are not included in this cost estimate. The Customer and the TP may make alternate arrangements for handling BA metering requirement responsibilities if mutually agreed to by both parties.

12 TELECOMMUNICATIONS

12.1 Communications Plan Recommendation Summary

Customer would install optical ground wire (OPGW) on the 115 kV generator tie line from the Generating Facility to the Point of Change of Ownership. Customer would provide excess fiber optic cable to be terminated in a TP-provided splice box mounted on the Point of Change of Ownership A-frame takeoff structure within the West Cheyenne substation.

Status/control/analog/alarm data as specified by the Joint Operating Committee would be available to the TP utilizing DNP3 protocol over the OPGW. Communication equipment, located in

Customer's Site, necessary to provide data specified by the Joint Operating Committee and this document to the TP are not included in this cost estimate.

Customer would be responsible for providing any communication circuits to Customer's Site as required by the Balancing Authority. These potential Customer costs are not included in this cost estimate.

12.2 Relay Remote Access / Substation LAN

The future West Cheyenne substation's infrastructure would allow for remote relay access by the TP.

12.3 Remote Terminal Unit (RTU)

It is assumed that the existing RTU at the future West Cheyenne substation would be adequate for this interconnection. If requested, a secondary RTU may be provided at additional Customer cost to reduce curtailment during planned or unplanned RTU downtime. Customer would provide communications equipment to allow a single physical port of the Cheyenne West RTU to:

- Transmit AGC set point
- Receive data specified by the Joint Operating Committee
- Receive additional data required for operating procedures or AGC operation

12.4 Protection Communication

Customer provided Optical Ground Wire (OPGW) would deliver a communication medium between protective devices at the West Cheyenne substation and Customer's Site.

13 PROCEDURES AND OPERATION

Details outlining procedures and operation would be addressed by the Joint Operating Committee prior to energization.

14 SYSTEM UPGRADES

The SIS report for the CLPT-G7 project identified impacts to the neighboring systems under a specific future scenario. That included the addition of the CLPT-G7 project, the addition of 125 MW of proposed generation at Cheyenne Prairie Generating Station, and the addition of the Wayne Child Phase II project. The customer should coordinate with Tri-State and WAPA as affected parties on any required mitigation of these issues.

- Owl Creek-Rockport Tap 115 kV continuous rating was exceeded following the simultaneous loss of the Archer-Ault and Ault-Terry Ranch 230 kV lines. The loading was within the 4-hour continuous rating of the facility.
- The Rockport-Nunn 115 kV line continuous rating was reached but not exceeded following the simultaneous loss of the Archer-Ault and Ault-Terry Ranch 230 kV lines.
- The Ault-Weld 230 kV line continuous rating was exceeded following the loss of the parallel Ault-Weld 230 kV line in cases with and without the CLPT-G7 project in service. The emergency rating was not exceeded in either instance.

14.1 Interconnection Customer's Interconnection Facilities

Interconnection Customer Interconnection Facility costs apply to facilities and equipment required by the TP and owned and operated by Customer from its Generating Facility to the Point of Change of Ownership. The costs for these facilities are paid by Customer and are not subject to transmission credits.

Facility	Upgrade Description	Cost Estimate	Implementation Timeframe
Generator Tie Line	Single circuit 115 kV line (795 ACSR) with OPGW	N/A	N/A
Phasor Measurement Unit	PMU and Phasor Data Concentrator at the high side of the GSU terminals.	\$50,000	2 Months
Total:		\$50,000	2 Months

14.2 Transmission Provider Interconnection Facilities

Transmission Provider Interconnection Facility costs apply to facilities and equipment required by the TP and owned and operated by the TP. This equipment is typically located between the Point of Change of Ownership and the Point of Interconnection. The costs for these facilities are paid by Customer.

Facility	Upgrade Description	Cost Estimate	Implementation Timeframe
New 'Cheyenne West' 115 kV substation terminal	New 115 kV, 2000 amp line terminal to accommodate the new 115 kV transmission line to the proposed wind facility collector substation; includes necessary substation A-frame steel, 115 kV metering instruments, line protection, and typical associated conductors	\$430,000	18-24 months
Total:		\$ 430,000	18-24 Months

14.3 Network Upgrade Costs

Network upgrades for this project are specified in the table below.

Facility	Upgrade Description	Cost Estimate	Implementation Timeframe
Transmission line from the intersection on the Swan Ranch-King Ranch 115 kV line to the Cheyenne West substation	Construct 2.2 miles of double circuit 115 kV transmission utilizing 795 ACSR on double circuit monopole structures.	\$ 2,160,000	18-24 months
New “Cheyenne West” 115 kV substation	Construct a new 115 kV, 2000 Amp, 3-position ring bus substation to provide 3 115 kV transmission line terminals; includes breakers, switches, instrument transformers, bus, conductors, protection and control systems, foundation and support systems, control building, and associated common equipment.	\$ 3,300,000 ¹	18-24 months
Total:		\$5,460,000	18-24 Months

14.4 Assumptions

1. Cost estimates are considered to be within +/- 20%, based on 2017 unit costs. With likely fluctuations in the price of raw materials, fuel, and labor, actual costs may vary in future years.
2. Cost estimate does not factor in any special permitting for the site or any special environmental considerations that may be required due to the nature or impact of the interconnecting project.
3. Project schedules are considered reasonably accurate but can be affected by permitting delays, extended land negotiations, equipment deliveries, weather, availability of workforce, and availability of outage clearance for construction.
4. Barring unforeseen complications with local permitting requirements, availability of system outages, strikes, resource limitations etc., the proposed schedule for final design and construction is estimated to take 18-24 months from an authorization to begin work.
5. Mitigation for any environmental/cultural issues is not included.
6. AFUDC does not apply if customer payments are made concurrent with performance of work.
7. The final in-service date would depend on when the TP facility outages can be reasonably secured for construction.
8. TP may elect to contract any or all parts of its responsibility.
9. The project schedule is based on having all permits, agreements, and authorizations completed prior to initiation of construction work.
10. Estimates are made primarily from review of existing plan and profile.
11. Does not include the cost of the generation tie line or provisions for right of way or easements to the POI which is the responsibility of Customer.

¹ Cost of property to locate and develop these facilities is not included in the estimated price. The location of this proposed substation facility is currently being negotiated/acquired under a separate proposal. Any cost allocation related to the use of the substation site to support this proposed wind interconnection facility is not included in the estimate. The proposed project costs, schedules, and construction timelines may be impacted by the availability and/or suitability of the site acquired.

12. Cost estimate does not include any special metering systems beyond standard Black Hills Energy interface metering, and does not account for third party (Generation Boundary, Control Area Boundary, etc.) requirements or equipment.
13. Cost estimate does not include any special protection or Control (Generation Interconnect, Load Shedding, Frequency Control, Automatic Generation Control, etc.) systems that may be required due to the nature or impact of the interconnecting project.
14. Cost estimate is based upon standard BHE utility substation design and construction practices and does not factor in any special requirements of the interconnecting customer or any joint facility owners.
15. Cost estimate does not include costs of upgrading or replacing equipment not owned by the TP as identified in the SIS report. The Interconnection Customer should coordinate with the equipment owners regarding any needed upgrades.

15 SCHEDULE

	Elapsed Months																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Execute Interconnection	X	X	X																						
Evaluate internal resources and develop statement of work and procure consultant (if necessary)																									
Design (Includes Operating Committee Documentation)			X	X	X	X	X	X	X	X	X	X	X												
Materials / equipment order and delivery							X	X	X	X	X														
Preparation of construction documents and secure contractors						X	X	X	X																
Construction										X	X	X	X	X	X	X	X								
Outage for interconnection																		X							
Testing and commissioning																			X						
Close out																				X					

Notes:

1. Project estimated to be complete a minimum of 18 months after authorization to begin work
2. Unforeseen delays due to permitting, weather, equipment delays, or lack of construction resources are not included in the above schedule
3. Lead times for major equipment based on current production schedules
4. Schedule assumes system outages would be available for station cutover when needed.